Industrial Electrical Heat Tracing Systems

Raychem

Engineering specification for industrial electrical heat-tracing systems

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1 SCOPE

This specification covers the requirements of materials and support services for heat-tracing systems supplied by the vendor. Neither the supply of the materials related to the connection of the power supply nor the installation of the entire system is part of this specification.

2 CODES, APPROVALS AND STANDARDS

The electric heat-tracing system shall conform to this specification. It shall be designed, manufactured and tested in accordance with the requirements stated in the applicable CSA, FM, IEC/IEEE 60079-30-1, IEEE and UL standards and US National and Canadian Electrical Codes.

3 ELECTRIC HEAT TRACE SYSTEM MATERIALS

3.1 Self-Regulating Heating Cable Systems

All heat-tracing applications with continuous operating (maintain) temperatures up to 400°F (205°C) or intermittent exposure temperatures up to 500°F (260°C) shall use self-regulating cables as per each cable's applicable ratings.

A. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.

B. An extended warranty against manufacturing defects for a period of 10 years shall be available.

C. All cables shall be capable of passing a 2.2 kV dielectric test for one minute after undergoing a 1.0 kg-0.7 m impact (IEC/IEEE 60079-30-1:2015, clause 5.1.5.1).

3.1.1 Freeze-protection and low operating temperature with no steam exposure

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating semi-conductive polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. Self-regulating heating cable shall be designed for a useful life of 20 years or more when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 20 years of usage at maximum continuous operating temperature.

D. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross- sectional area. The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

E. In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

Table 1 Minimum Self-Regulating Indices

Heating cable	S.R. index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

F. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.

G. The heating cable shall be Raychem BTV-CT or BTV-CR self-regulating heater, with continuous operating (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

3.1.2 Freeze protection and medium operating temperature with no steam exposure

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating semi-conductive polymeric core that controls power output so that the cable has a temperature identification number (T-rating) of T4 (275°F or 135°C) without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. Self-regulating heating cable shall be designed for a useful life of 20 years or more when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 20 years of usage at maximum continuous operating temperature.

D. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross- sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

E. The heating cable shall be Raychem QTVR-CT self-regulating heater, for continuous and intermittent exposure capability up to 225°F (110°C).

3.1.3 Freeze protection and high operating temperature with steam exposure

A. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires, separated by a fluoropolymer spacer and helically wrapped with a self-regulating semi-conductive core that controls power output so that the cable has an unconditional temperature identification number (T-rating) of T3A (356°F/180°C) up to 8 W/ft and T3 (392°F or 200°C) for 10, 12, 15 W/ft (240 V), 10 W/ft (120 V) versions and T2D (419°F or 215°C) for 15, 20 W/ft (120 V), 20 W/ft (240 V) version without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. Self-regulating heating cable shall be designed for a useful life of 30 years when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 30 years of usage at maximum continuous operating temperature.

D. Self-regulating heating cable shall have minimum 95% power retention after 10 years at maximum operating temperature.

E. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross- sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

F. The heating cable shall be Raychem XTVR-CT self-regulating heater, for continuous operating maintain capability up to 302°F (150°C) and intermittent exposure capability up to 482°F (250°C or 250 psi steam).

3.1.4 Freeze protection and very high operating temperature with steam exposure

A. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires, separated by a solid self-regulating semi-conductive core including pressure extruded electrical insulation that controls power output so that the cable has an unconditional temperature identification number (T-rating) of T3 (392°F or 200°C up to 15 W/ft, T2D (419°F or 215°C) for 20 W/ft and T2B (464°F or 240°C) for 28 W/ft without use of thermostats.

B. The cable wattage range should include 3, 5, 8, 10, 12, 15 and 20 W/ft rated at 120 V and 3, 5, 8, 10,12, 15, 20 and 28 W/ft rated at 240 V to closely match the heat loss in various operating conditions.

C. Self-regulating heating cable shall be designed for a useful life of 30 years when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 30 years of usage at maximum continuous operating temperature.

D. Self-regulating heating cable shall have minimum 95% power retention after 10 years at maximum operating temperature.

E. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

F. The heating cable shall have a nickel copper braid wire with a cross-sectional area being equal to or greater than conductor cross- sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

G. The cable shall have a minimum installation temperature of –76°F (–60°C) with minimum bend radius of 1 inch at that temperature.

H. The heating cable shall be Raychem HTV-CT self-regulating heater, for continuous operating (maintain) capability up to 400°F (205°C) and intermittent exposure capability up to 500°F (260°C).

3.1.5 Systems for division 1 hazardous locations

The following requirements shall apply in addition to the criteria specified in paragraph 3.1.1, 3.1.2, 3.1.3 or 3.1.4.

A. The self-regulating heating cable shall be specifically approved for use in Division 1 locations.

B. A ground-fault protection device set at 30 mA, with a nominal 100 ms response time, shall be used to protect each circuit.

C. The temperature identification number (T-rating) of the cable used shall comply with regulatory requirements as applicable.

D. Connection methods used with the cable shall be compatible and approved as a part of the system manufactured and supplied by the heating cable vendor for use in the Division 1 location.

E. For plastic pipe and vessel applications, the heating cable shall be Raychem BTV-CT self- regulating heaters, with continuous operating capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

F. The heating cable shall be Raychem QTVR-CT self-regulating heaters, for continuous and intermittent exposure capability up to 225°F (110°C).

G. The heating cable shall be Raychem XTVR-CT self-regulating heaters, for continuous operating (maintain) capability up to 302°F (150°C) and intermittent exposure capability up to 482°F (250°C or 250 psi steam).

H. The heating cable shall be Raychem HTV-CT self-regulating heaters, for continuous operating (maintain) capability up to 400°F (205°C) and intermittent exposure capability up to 500°F (260°C).

3.1.6 Terminations for nonhazardous and hazardous locations

A. All connection kits used to terminate heating cables, including power connectors, splices, tees, and connectors shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer as this voids the approvals and warranty.

B. In order to keep connections dry and corrosion resistant, connection kits shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated TYPE 4X. The connection kit stand shall allow for up to four inches (100 mm) of thermal insulation.

C. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance-free operation, and ease of reentry.

D. Connection kits shall be rated to a minimum installation temperature of –67°F (–55°C), maximum ambient temperatures of 132°F(56°C), and maximum pipe temperature of 500°F (260°C). The connection kits with integral LED lights should have the ambient temperature range of –40°F (–40°C) to 104°F (40°C).

E. The connection kit system shall be Raychem JBS-100-L-A, E-100-L-A, or JBM-100-L-A complete with integral LED power indicating light. The JBM-100-L-A connection kit shall serve as complete power, splice, or tee connection for up to three BTV, QTVR, XTVR or HTV industrial parallel heating cables.

3.2 Power-Limiting Heating Cable Systems

Heat-tracing applications with continuous operating (maintain) temperatures up to 455°F (235°C) or power-off exposure temperatures up to 500°F (260°C) shall use power-limiting cables. Continuous operating (maintain) temperatures are based on wattage and voltage used; consult with vendor for specific cable temperature limits. Applications below 500°F (260°C) continuous exposure, power-off, shall consider power-limiting cables if more than one run of self-regulating heating cable is required.

The decision between self-regulating heating cable and power-limiting heating cable shall be made considering the need for a T-rating that is not dependent on the specific application (this is provided by self-regulating heating cables) and the number of runs of heat tracing required for the application. In some applications power-limiting heaters may require using fewer runs due to higher power output at higher temperatures.

A. Power-limiting heating cable shall use a metallic heating element that varies its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be a parallel-zoned heating cable with a positive temperature coefficient heating element spirally wound around a flexible glass fiber core. The cable shall be designed such that it can be crossed over itself one time and cut to length in the field.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. Maximum heating cable sheath temperature, per either the FM or CSA method of calculation, shall be submitted with the bid or design for all Division 1 and Division 2 applications.

D. The power-limiting heating cable shall have 12 AWG copper bus wires.

E. A warranty against manufacturing defects for a period of 10 years shall be available.

F. All cables shall be capable of passing a 2.2 kV dielectric test for one minute after undergoing a 1.0 kg-0.7 m impact (IEC/IEEE 60079-30-1:2015, clause 5.1.5.1).

G. The heating cable shall be Raychem VPL-CT power-limiting heater, with continuous operating (maintain) capability of up to 455°F (235°C), depending on power output required, and intermittent exposure capability up to 500°F (260°C).

3.2.1 Terminations for nonhazardous and hazardous locations

A. All connection kits used to terminate heating cables—including power connectors, splices, tees, and connectors—shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer as this voids the approvals and warranty.

B. In order to keep connections dry and corrosion resistant, connection kits shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated TYPE 4X. The connection kit stand shall allow for up to four inches (100 mm) of thermal insulation.

C. Terminals shall be the spring clamp wire connection type to provide reliable connection, maintenance-free operation, and ease of reentry.

D. Heating cable terminations shall use cold-applied materials and shall not require the use of a heat gun, torch, or hot work permit for installation.

E. Connection kits shall be rated to a minimum installation temperature of –67°F (–55°C), maximum ambient temperatures of 132°F(56°C), and maximum pipe temperature of 500°F (260°C). The connection kits with integral LED lights should have the ambient temperature range of –40°F (–40°C) to 104°F(40°C).

F. The connection kit system shall be Raychem JBS-100-L-A, E-100-L-A, or JBM-100-L-A complete with integral LED power indicating light. The JBM-100-L-A connection kit shall serve as complete power, splice, or tee connection for up to three VPL industrial parallel heating cables.

3.3 Mineral Insulated Heating Cable Systems

All heat-tracing applications with continuous operating (maintain) temperatures above 300°F (150°C) to 455°F (230°C), depending on power output required, or intermittent exposure temperatures above 500°F (260°C) shall use factory-terminated, mineral insulated (MI) cables.

MI heating cable shall be magnesium oxide insulated, with copper or alloy conductors and seamless Alloy 825 sheath. The heating section of the cable shall be joined to a cold lead also made of Alloy 825.

Each cable shall be factory-terminated to the required length, consisting of the lengths required for the pipe or equipment, plus an allowance for areas of additional heat loss such as valves, flanges, fittings, supports, and the like, plus a reasonable excess to allow for field variations. The cold lead section shall be seven feet long unless otherwise specified.

Maximum heating cable sheath temperature, per approved engineering design software, shall be submitted with the bid or design for all Division 1 (Zone 1) and Division 2 (Zone 2) applications.

Each cable shall be shipped with the catalog number marked on the outside of the package, and a permanent metallic cable tag containing the heating cable length, wattage, voltage, and current draw. If the cable has been designed for a hazardous location, the tag shall also indicate the area classification and heat-tracing circuit number.

A warranty against manufacturing defects for a period of 10 years shall be available.

The heating cable shall be Raychem (Alloy 825), mineral insulated heating cable with a maximum application temperature for the heating units of 1022°F (550°C) and a maximum exposure temperature for the heating cable of 1200°F (650°C).

3.4 Longline Systems

A. Self-Regulating, two-wire geometry, freeze protection for circuit lengths 500–2000 feet. For freeze protection applications, without high temperature exposure, up to 2000 feet, a two-wire self-regulating heater is often the best choice.
   1. The heating cable shall consist of two 10 AWG nickel-plated copper bus wires embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. The cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without the use of thermostats.
   2. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
   3. The heating cable shall be Raychem LBTV2-CT for circuit lengths of 500–1125 feet, with continuous operating temperature up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

B. Constant-Wattage Series Resistance, Freeze Protection and Process Temperature Maintenance up to 482°F (250°C) with Steam Exposure for circuit lengths 500–12,000 feet. For process temperature maintenance and freeze protection with steam exposure, a constant wattage series resistance heater is often the best choice, particularly when more than one run of self-regulating heater is needed.
   1. The heating cable shall be a series resistance constant wattage heater. It shall consist of one, two or three copper conductors or copper alloy conductors insulated with high temperature heavy-walled fluoropolymer.
   2. The heating cable shall have a tinned or nickel-plated copper braid to provide a ground path. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
   3. The heating cable shall be constant wattage Raychem SC, with continuous exposure capability up to 400°F (204°C), Raychem SC/H with continuous exposure capability up to 482°F (250°C).

C. Constant-Wattage, Mineral Insulated (MI), Series Resistance, Freeze Protection and Process Temperature Maintenance from 482°F (250°C) to 1022°F (550°C) with Steam Exposure with circuit lengths 5,000-10,000 feet. A constant wattage Alloy 825 series resistance heater is often the best choice for high temperature, longline, and corrosion resistant applications.
   1. MI cable shall be magnesium oxide insulated, with copper or alloy conductors and seamless Alloy 825 sheath. The heating section of the cable shall be joined to a cold lead also made of Alloy 825.

2. Each cable shall be factory-terminated to the required length, consisting of the lengths required for the pipe or equipment, plus an allowance for areas of additional heat loss, such as valves, flanges, fittings, supports, and the like, plus a reasonable excess to allow for field variations. The cold lead section shall be seven feet long unless otherwise specified.
3. Maximum heating cable sheath temperature, per approved engineering design software, shall be submitted with the bid or design for all Division 1 (Zone 1) and Division 2 (Zone 2) applications.
4. Each cable shall be shipped with the catalog number marked on the outside of the package, and a permanent metallic cable tag containing the heating cable length, wattage, voltage, and current draw. If the cable has been designed for a hazardous location, the tag shall also indicate the area classification and heat-tracing circuit number.
5. A warranty against manufacturing defects for a period of 10 years shall be available.
6. The heating cable shall be Raychem XMI (Alloy 825) MI mineral insulated heating cable with a maximum application temperature for the heating units of 1022°F (550°C) and a maximum exposure temperature for the heating cable of 1200°F (650°C).

D. Skin-Effect Heat-Tracing Systems, Circuit Lengths up to 31 miles (50 km), Freeze Protection and Process Temperature Maintenance, and exposure up to 500°F (260°C). For very long lines, skin- effect tracing is required in order to minimize power connection locations.
   1. The heating system shall consist of an electrically insulated, temperature-resistant conductor with high-temperature, heavy-walled insulation installed inside a heat tube and connected to the tube at the far end.
   2. The heat tube shall be ferromagnetic and thermally coupled to the carrier pipe that is being traced.
   3. The design must be completed by the system manufacturer.
   4. The system manufacturer should perform the installation.
   5. The heat-tracing system shall be Raychem STS (Skin-Effect Heat-Tracing System).

3.5 Heat-Trace Power Distribution Panels

3.5.1 Group heat-tracing circuit control

A. For freeze protection or group control process-temperature maintenance systems, power distribution panels shall consist of an enclosure, including a panelboard with ground-fault protection devices (30 mA trip level).
B. The panels shall provide ground-fault alarm capabilities.
C. If more than one circuit is required, a main contactor shall be used.
D. The panels shall be capable of operating with ambient-sensing or proportional ambient-sensing controllers.
E. The panels shall be capable of alarming of individual heat-tracing circuits.
F. The panels shall be approved for use in nonhazardous or hazardous locations as required by the installation environment.
G. The panels shall be capable of providing audible and visible alarms.
H. The panel shall be the Raychem HTPG heat-tracing power distribution panel.

3.5.2 Individual heat-tracing circuit control

A. For individual control process temperature maintenance systems, power distribution panels shall consist of an enclosure, including a panelboard with ground-fault protection devices (30 mA trip level).
B. The panels shall provide ground-fault alarm capabilities.
C. Circuits shall be switched by individual contactors capable of being operated by line-sensing controllers.
D. The panels shall be capable of monitoring and alarming of individual heat-tracing circuits.
E. The panels shall be approved for use in nonhazardous and hazardous locations as required by the installation environment.
F. The panels shall be capable of providing audible and visible alarms.
G. The panel shall be the Raychem HTPI heat-tracing power distribution panel.

3.6 Thermostats and Contactors

Freeze protection systems shall operate using self-regulating control or with the Raychem AMC-1A, Raychem AMC-F5 thermostat or Raychem Elexant 3500i Electronic Thermostat in nonhazardous locations, and Raychem AMC-1H thermostat, or Raychem Elexant 3500i Electronic Thermostat in hazardous locations, as supplied by Chemelex.

Process temperature maintenance systems shall operate using self-regulating control or with Raychem AMC-1B thermostat or Raychem Elexant 3500i Electronic Thermostats in nonhazardous locations and Raychem E507S-LS or Raychem Elexant 3500i Electronic Thermostats in hazardous locations.

3.7 Control and Monitoring Systems

All control and monitoring systems shall be capable of communicating for central programming, monitoring, and alarm annunciation. All systems shall include, but not be limited to, the following:

A. Alarm limits and setpoint temperatures shall be programmable from the central monitoring and control panel in °F and °C. The system shall include multi-language support and password protection to prevent unauthorized access to the system.

B. The heat tracing load shall be switched by solid-state or mechanical relays with a minimum rating of 30 Amps at 104°F (40°C), and have the option of single, dual, or 3-pole switching without de-rating due to ambient temperatures up to 104°F (40°C).

C. The system shall be capable of assigning one or more RTDs to a circuit to monitor temperature.

D. The system shall provide high temperature cut-out capability when using multiple RTDs.

E. The system shall monitor temperature, and load current to the systems.

F. The system shall monitor ground-fault current and offer the option of alarm only or alarm and trip if the ground fault exceeds the selectable level. Separate ground fault alarm and trip settings shall be supported.

3.7.1 Multipoint control and monitoring systems for single circuit and multi-circuit applications general

A. The system shall have UL, CSA, ETL (or equivalent) approval for Class I, Division 2, Groups A, B, C, D and Class I, Zone 2, Group IIB+H2 when using a solid-state switching devices or using electromechanical relays with either a Z-purge system, or encapsulated circuit breakers rated for hazardous areas.

B. Enclosure types shall be TYPE 12 (painted steel, indoor installation), TYPE 4/3R (painted steel, outdoor installation), or TYPE 4X/3RX (stainless steel, fiberglass, outdoor installation) as required by project specification.

C. Field mounted switch racks (skid assemblies) shall be available in various configurations. They shall integrate a distribution transformer dedicated to the heating system, a power distribution panel board suitable for the area classification and a heat trace control panel. Power distribution and control components may also be integrated into a common panel. The entire switch rack shall be factory assembled, tested, and approved by UL, CSA, ETL (or equivalent).

D. The system shall use 3-wire 100-ohm platinum Resistance Temperature Detectors (RTDs), or temperatures derived from 4-20 mA sources for temperature sensing.

E. The system shall allow multiple RTD temperature inputs per heat tracing circuit for monitoring, control and fault indication. Each sensor shall be configurable for control, monitoring or high temperature cut-out or combinations thereof.

F. The system shall provide the following control mode options: On/Off Control with a user selectable dead band, Proportional Ambient Sensing Control (PASC), Always On and Always Off. For controllers utilizing Solid State output Relays (SSRs), Proportional Control with configurable power and/or current limiting shall also be available.

G. The controllers shall be available to support single or 3-phase heating loads of up to 60 Amps and 600 VAC with ground-fault detection.

F. Each control module shall provide an individual fail-safe dry-contact alarm relay that may be connected to an external annunciator.

G. For controllers utilizing SSRs, a soft-start feature shall be available to ramp the output from 0-100% over time to reduce heater inrush currents.

H. The controller shall be capable of testing the heating circuit at a user-defined interval. The test shall terminate immediately upon detection of any unsafe condition (GF, High Temperature) and generate the appropriate alarms.

I. The system shall be compatible with all types of heating cables and capable of performing the following functions:

1. Controlling and monitoring pipe temperatures.
2. Providing real-time temperature and alarm log readouts.
3. Providing alarms in the event of low or high pipe temperature, low or high heater current, high ground-fault current, ground-fault trip, relay failure, and sensor failure.
4. Providing remote alarm annunciation.
5. Interfacing with personal computers and DCS systems.

H. The system shall support a touch screen user interface (UI) mounted on the panel to display circuit status, monitoring data and fault information as well as provide heat-tracing circuit configuration capability. A version of the UI shall be approved for use in Class I Division 2/Zone 2 environments as required. A remote mountable version of the UI shall be available if available if locating the user interface remotely from the panel is desired.

I. The UI shall have programmable form-C alarm relay.

J. The system shall be capable of updating UI operating software in the field.

K. The system shall support Modbus RTU and Modbus/TCP communications protocols and be supplied complete with RS-485 and Ethernet communications interface capabilities. Fiber-optic interfaces, pre-packaged communications converters, repeaters, and wireless interfaces shall be available as options.

L. Devices with multiple communications ports shall support simultaneous connections to external devices and automatically synchronize status and configuration information across all ports.

M. The heat trace vendor shall offer supervisory software for central programming, monitoring, and alarm annunciation. The supervisory software shall support a multi-user architecture allowing multiple simultaneous users and/or workstations, and be capable of integrating all system data into a central database or distributed repository. All information shall be available from any workstation and the software shall provide full user permissions and grouped access features.

Single/Dual Circuit Controllers

A. The single and dual-point controllers shall allow at least two hardwired RTD inputs per circuit.

B. The controller shall monitor heater voltage and support high and low voltage alarming.

C. The controller shall monitor control temperature and support high temperature cut-off.

D. The system shall be the Raychem Elexant 4010i, 4020i, 3500i, Raychem 920 or Elexant 7300i heat-tracing control systems.

Multi-Circuit Panels

A. The multi-point panels shall have the option to include integral power distribution.

B. The multi-point panels shall be capable of using RTDs that are wired directly to the internal control or expansion modules. The system shall allow up to four RTD inputs to be assigned to any circuit within the control panel. Expansion of the number of RTDs shall not result in a loss of the number of available heating circuits in the panel.

C. The multi-point panels shall support external field mounted RTD multiplexing modules and allow the temperatures to be assigned to any circuit within the control panel. RTD multiplexing modules shall be capable of being installed at a distance of up to 1200 m (4000 ft) from the control panel without additional equipment.

D. The multi-point control modules shall provide programmable dry contact alarm relays.

E. The controller shall have the option to monitor system voltage and support high and low voltage alarming.

F. The system shall be the Raychem NGC-30 heat-tracing control system.

3.7.2 Single point control and monitoring systems for single circuit and multi-circuit applications general

A. The system shall have ETL (or equivalent) approval for Class I, Division 2, Groups A, B, C, D and Class I, Zone 2, Group IIB+H2 when using a solid-state switching device or using electromechanical relays with either a Z-purge system, or encapsulated circuit breakers rated for hazardous areas.

B. Enclosure types shall be TYPE 12 (painted steel, indoor installation), TYPE 4/3R (painted steel, outdoor installation), or TYPE 4X/3RX (stainless steel, fiberglass, outdoor installation) as required by project specification.

C. Field mounted switch racks (skid assemblies) shall be available in various configurations. They shall integrate a distribution transformer dedicated to the heating system, a power distribution panel board suitable for the area classification and a heat trace control panel. Power distribution and control components may also be integrated into a common panel. The entire switch rack shall be factory assembled, tested, and approved by UL, CSA, ETL (or equivalent).

D. The control solution shall provide single, dedicated, independent control modules for each heat tracing circuit to deliver the highest level of heat management system reliability.

E. The system shall use 3-wire 100-ohm platinum Resistance Temperature Detectors (RTDs) for temperature sensing.

F. The system shall allow multiple RTD temperature inputs per heat tracing circuit for monitoring, control and fault indication. Each sensor shall be configurable for control, monitoring or high temperature cut-out or combinations thereof.

G. The system shall provide the following control mode options: On/Off Control with a user selectable dead band, Proportional Ambient Sensing Control (PASC), Always On and Always Off. For controllers utilizing Solid State output Relays (SSRs), Proportional (PID) Control with adaptive power limiting shall also be available.

H. Each control module shall provide one digital input that may be configured for various functions such as forcing the controller output on or off.

I. The controllers shall support single and 3-phase heating loads of up to 60 Amps and 600 VAC with ground-fault detection.

J. For controllers utilizing SSRs, Circuit Breaker Limiting and Switch Limiting features for protection of circuit breakers and SSR relay outputs shall be available.

K. Each control module shall provide an individual fail-safe dry-contact alarm relay that may be connected to an external annunciator.

L. For controllers utilizing SSRs, an adaptive soft-start feature shall be available to ramp the output from 0-100% over time to reduce heater inrush currents.

M. The controller shall be capable of testing the heating circuit at a user-defined interval. The test shall terminate immediately upon detection of any unsafe condition (GF, High Temperature) and generate the appropriate alarms.

N. The system shall be compatible with all types of heating cables and capable of performing the following functions:

1. Controlling and monitoring pipe temperatures.
2. Providing real-time temperature and alarm log readouts.
3. Providing alarms in the event of low or high pipe temperature, low or high heater current, high ground-fault current, ground-fault trip, relay failure, and sensor failure.
4. Providing remote alarm annunciation.
5. Interfacing with personal computers and DCS systems.

The system shall support an optional touch screen user interface (UI) mounted on the panel to display circuit status, monitoring data and fault information as well as provide heat-tracing circuit configuration capability. A version of the UI shall be approved for use in Class I Division 2/Zone 2 environments as required. A remote mountable version of the UI shall be available if locating the user interface remotely from the panel is desired.

The UI shall not be used for heat trace control. All heat trace control shall be performed independently by the control modules.

The system shall be capable of updating UI operating software and controller firmware in the field.

The system shall support Modbus RTU and Modbus/TCP communications protocols and be supplied complete with RS-485 and Ethernet communications interface capability. Fiber-optic interfaces, pre-packaged communications converters, repeaters, and wireless interfaces shall be available as options.

Devices with multiple communications ports shall support simultaneous connections to external devices and automatically synchronize status and configuration information across all ports.

The heat trace vendor shall offer supervisory software for central programming, monitoring, and alarm annunciation. The supervisory software shall support a multi-user architecture allowing multiple simultaneous users and/or workstations, and be capable of integrating all system data into a central database or distributed repository. All information shall be available from any workstation and the software shall provide full user permissions and grouped access features.

The system shall provide load shedding capabilities that may be initiated by external devices. Multiple load shedding zones shall be supported, allowing select groups of controllers to be put into load shedding mode.

The load shedding command shall be periodically broadcast on the network. The controller shall manage the load shedding mode and automatically revert to normal operation should the load shedding commands fail to be broadcast.

The Controllers shall provide a fail-safe load shedding mode to ensure that pipe temperatures do not drop below acceptable levels even during load shedding events.

4 ENGINEERING

A. The Heat Tracing Vendor shall be given the latest revisions of the documents listed below to facilitate Estimates, Proposals, and Detailed Engineering.

1. Project Management Inputs
   a. Project Schedule(s)
   b. Work Breakdown Structure definition (WBS)
2. Technical Inputs
   a. Project specifications related to Heat Tracing
      i. Standard(s) for Electrical Heat Tracing
      ii. Standard(s) for Electrical Equipment
      iii. Standard(s) for Electrical Installations
      iv. Standard(s) for Pipe and Equipment Insulation
      v. Standard(s) for Removable Pad/Blanket Insulation
      vi. Standard(s) for Instrumentation Winterization
3. Project technical drawings and documents
   a. P&IDs
   b. EHT Control Panel / Controller Communications block diagrams / details
   c. Line list(s) - (.xlsx or .xls preferred)
   d. Plot plan(s)

e. Area classification drawings and AIT designations
f. Piping MTO from 3D model - (.xlsx or .xls preferred)
g. Piping isometrics (.idf or .pcf preferred)
h. Instrument & analyzer list - (.xlsx or .xls preferred)
i. Instrument specification sheets/details
j. Instrument and analyzer location plans
k. Equipment list - (.xlsx or .xls preferred)
l. Equipment arrangement drawings / data sheets
m. Substation / Primary Power feed locations for EHT
n. Power Distribution plans for cable tray and/or conduit
o. Electrical installation details
p. Identify any critical pipes and/or instruments for EHT
q. Viewer files from 3D Model

B. The Heat Tracing Vendor shall provide a detailed design utilizing TRACERLYNX heat tracing design software or equal. At minimum, the design must provide the following:
1. Circuit identification number
2. Maintain temperature
3. Line size and insulation
4. Heat loss
5. Amount and type of heating cable required
6. Overall BOM for heat tracing material
7. Heating cable service voltage
8. Heating cable power output at the maintain temperature
9. Minimum and maximum maintain temperature vs. minimum and maximum ambient temperatures
10. Circuit breaker sizing
11. EHT Control Panel / Controller Communications parameters

C. The Heat Tracing vendor shall provide the following deliverables at the buyer's request.
1. Heat Tracing Isometric Drawings
2. Heat Tracing Database
3. Heat Tracing Schedules
4. Panel Board Schedules
5. Control Panel Layouts and Details
6. Power/Control Cable or Conduit Schedules
7. Wiring Schematics (control panels)
8. Power & RTD Location Database
9. Key Plan for EHT Layout
10. EHT Zoning P&IDs
11. Engineering Work Packages (EWPs) for EHT, Insulation, Instrument Winterization and associated Tubing and Tube Bundle, Power Distribution, and Analyzer Tubing and Tube Bundle, as applicable.
12. Communications block diagrams, or equivalent

5 TESTING

Factory inspections and tests for self-regulating, power limiting, series constant wattage and constant wattage (MI) heater cables shall include but are not limited to the following:

A. Testing shall be done per the latest IEEE /IEC 60079-30-2 standard test section and applicable manufacturer's standards. Insulation resistance shall be measured from heating device conductors to metallic braid, metallic sheath, or other equivalent electrically conductive material with a 500 Vdc test voltage. However, it is strongly recommended that higher test voltages be used—mineral insulated trace heaters should be tested at, but not exceed, 1000 Vdc, and polymeric insulated trace heaters should be tested at 2500 Vdc.

B. In the field, all heater cables shall be tested for insulation resistance. The following separate field megohmmeter readings shall be taken on each cable:
1. When received at jobsite before installation

2. After installation, but before insulation is applied
3. After insulation has been installed

C. The readings obtained shall satisfy the minimum acceptable readings per IEEE/IEC 60079-30-2 standard, otherwise the heater cable is not acceptable and shall be replaced.

D. It is strongly recommended that the manufacturer's minimum recommended IR values be observed as tabulated below:

Source	Manufacturer			IEC/IEEE 60079-30-2
Cable Type	Self-Regulating/ Power- Limiting	Constant Wattage (Polymer)	Constant Wattage (MI)	All
IR Values (Megohms)	Recommended Minimum IR Value			Absolute Minimum Acceptable
On Receipt	1000	100	100	20
After Installation	1000	100	20	20
After Insulation	1000	100	20	20 (5 MI only)
Start Up/Commissioning	1000	100	10	20 (5 MI only)

Note: Insulation resistance readings should be recorded promptly at each of the different stages after the cable has been received, installed, insulated and commissioned.

E. Field megohmmeter tests shall be recorded for each heater cable, and certified reports shall be submitted to the user.

F. Adverse weather conditions such as high humidity can influence measuring equipment/ test leads/ connections and appropriate steps should be taken to avoid false insulation resistance readings.

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